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"I have been in the habit of advising my students to dissect the CAT as a convenient preliminary to practical Human Anatomy."—*Joseph Leidy.*

"It seems to me that the first dissections should be made on CATS and dogs until a good technique has been acquired, so that the supply of human cadavers, which is always insufficient, can be fully utilized to the best advantage."—*J. S. Billings.*

"There is so close a solidarity between ourselves and the animal world that our inaccessible inward parts may be supplemented by theirs. A SHEEP'S heart or lungs or eye must not be confounded with those of man ; but so far as the comprehension of the elementary facts of the physiology of circulation and of respiration and of vision goes, the one furnishes the needed anatomical data as well as the other."—*Huxley.*

# PHYSIOLOGY PRACTICUMS

EXPLICIT DIRECTIONS FOR EXAMINING

PORTIONS OF THE CAT, AND THE HEART, EYE,  
AND BRAIN OF THE SHEEP

AS AN AID IN THE

STUDY OF ELEMENTARY PHYSIOLOGY

SECOND EDITION, REVISED

WITH THIRTY FIGURES

BY

BURT G. WILDER, B.S., M.D.,

Professor of Physiology, Vertebrate Zoölogy, and Neurology in Cornell University ; formerly  
Professor of Physiology in the Medical School of Maine and the University of  
Michigan ; President (1885) of the American Neurological Association and of the Biological Section of the American Association Adv. Science, etc.

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*By the author:* Dissection of the Sheep's Brain : being part IV of Physiology Practicums, with Plates XVIII-XXV and an Appendix on the Removal and Preservation of the Brain. Price 40 cts., post-paid.

*By the author and S. H. Gage:* Anatomical Technology as Applied to the Domestic Cat : an Introduction to Human, Veterinary, and Comparative Anatomy. Third, from the second revised, edition. Pp. 600, 120 figs, 4 lithograph plates. A. S. Barnes & Co., New York, 1892. \$4.50.

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## PREFACE TO THE FIRST EDITION.

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About ten years ago, in the effort to enable the members of the general class in Physiology at Cornell University (150-180 in number) to study for themselves intelligently certain parts of the cat and sheep as an aid to the comprehension of the functions and relations of the corresponding human organs, I put alcoholic specimens before them and wrote on the blackboard brief directions which were orally amplified and illustrated. A few years later these directions were written upon cloth sheets that were suspended before the class. They were amplified and printed in the fall of 1889 and issued in their present form in 1892.

The separation of the sheets and plates has obvious inconveniences but upon the whole the practical advantages are greater.

From the first the assistants and students have cordially coöperated toward increasing accuracy and explicitness.

It is to be hoped that ere long as much as is here included may be required for admission to this and other universities, so that the instruction therein may commence upon a foundation both higher and more substantial than at present.

*Ithaca, N. Y., December 26, 1893.*

## PREFACE TO THE SECOND EDITION.

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The text has been revised and largely rewritten. An effort has been made to correct the errors and omissions detected during the three years' use of the work at Cornell University and elsewhere. For helpful suggestions I am particularly indebted to my assistants, Dr. P. A. Fish and Dr. B. B. Stroud.

The changes in the illustrations comprise new figures of the cat's skeleton, and of the sheep's heart and brain. Two outlines have been introduced into the text.

The order has been modified so as to bring the examination of the head and neck just before that of the eye and brain. The eleven practicum are combined so as to form four Parts, each dealing with a natural group of subjects.

A teaching experience of twenty-seven years leads me to believe that explicitness should be a main feature of directions for beginners. To credit them with unlikely knowledge, judgment and skill, or with inspiration that will serve in place of those attributes, may compliment them and simplify the task of the writer. But there result perplexities, the formation of faulty methods, and the waste of time and material.

When, however, there has once been established a sound basis of fact and manipulation, the student may safely and profitably venture upon unfamiliar ground. He may either apply the directions to different forms, or re-examine the same forms in different ways. For example, the brain of the cat, dog, monkey or man may compared with that of the sheep, and the sheep's brain may be explored in ways other than that presented in the following pages.

*September 20, 1895.*



# CONTENTS.

	PRACTICUM.	SUBJECT.	PAGES.	PLATES.
PART I.	I.	The Cat : Its Form, Skeleton, Skin-Muscles, and Axillary Vessels and Nerves .....	5- 8	I-IV
	II.	Dissection of the Cat's Arm .....	9-16	I, II, IV, V
PART II.	III.	Thoracic Viscera of the Cat .....	17-23	VI-VIII
	IV.	The Abdomen of the Cat .....	23-28	VIII-XI
	V.	The Heart of the Sheep .....	29-36	XII-XIV
PART III.	VI.	The Head and Neck of the Cat .....	37-48	XV-XVII
	VII.	The Eye of the Sheep .....	47-52	XVII-XX
PART IV.	VIII.	The Brain of the Sheep : its Ectal Features and Segmental Constitution .....	49-53	XVIII-XXII
	IX.	The Mesal Aspect of the Sheep's Brain ; Endymal Continuity and Cœlian Circumscription .....	54-62	XXIII-XXV
	X.	Dissection of the Sheep's Brain .....	63-67	
	XI.	Dissection of the Brain continued ; Study of its Transections .....	68-74	XVIII-XXV

## LIST OF PLATES.

- Plate I. The Skeleton of the Cat. From Straus-Durckheim's "Anatomie du Chat."  
 II. The Ectal Muscles of the Cat, seen from the Left Side.  
 III. Ventral Aspect of the Cat's Thorax.  
 IV. Right Axillary Region of the Cat after division of the Pectoral Muscles.  
 V. Right Arm of Cat, partly dissected.  
 VI. Thorax of the Cat, opened from the Right Side to show the Lungs.  
 VII. The Cat's Thorax, after removal of the Right Lung.  
 VIII. Diaphragm of the Cat, its Cephalic or Thoracic Aspect.  
 IX. Abdominal Viscera of the Cat, from the Left Side.  
 X. Abdominal Viscera of the Cat, after removal of the Small Intestine.  
 XI. Pelvic Viscera of the Female Cat.  
 XII. Ventral and Dorsal Aspects of the Sheep's Heart. Two figures.  
 XIII. Heart of the Sheep, the Right Auricle opened.  
 XIV. Heart of the Sheep, the Left Side opened.  
 XV. The Salivary Glands of the Cat. From "Anatomical Technology."  
 XVI. Head and Neck of the Cat, from the Left Side, partly dissected.  
 XVII. Mesal Aspect of the Right Half of the Cat's Head. From "Anatomical Technology" and "Reference Handbook of the Medical Sciences."  
 XVIII. Brain of the Sheep, the Cerebrum sliced to near the level of the Callosum.  
 XIX. Ventral Aspect of the Sheep's Brain, the Eyes attached.  
 XX. Ventral Aspect of the Sheep's Brain after the removal of the Hypophysis and Parts of the Cerebrum and Cerebellum.  
 XXI. Left Side of the Sheep's Brain after removal of most of the Cerebrum and Cerebellum.  
 XXII. Dorsal Aspect of the Sheep's Brain after removal of parts of the Cerebrum and Cerebellum.  
 XXIII. Mesal Aspect of the Right Half of the Sheep's Brain.  
 XXIV. Sheep's Brain, the Paraceles (Lateral Ventricles) exposed.  
 XXV. Transection of the Sheep's Brain at the level of the Medicommissure ; Part of the same enlarged. Two figures.

## FIGURES IN THE TEXT.

- Fig. 1, p. 6. Left Side of the Cat.  
 Fig. 2, p. 19. Right Side of the Cat's Thorax, showing Lines of Incision. *On p. 19 this figure is wrongly numbered 6.*  
 Fig. 3, p. 69. Dissection of the Left Olfactory Bulb of the Sheep.



# PHYSIOLOGY PRACTICUMS.

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## PART IV. THE BRAIN.

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### PRACTICUM VIII. THE GENERAL FEATURES AND SEGMENTAL CONSTITUTION OF THE BRAIN.

PLATES REQUIRED : XVIII-XXIII.

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*Suggestion.*—The comparative unfamiliarity of most students with the parts of the brain and with their names renders it particularly desirable that the directions should be read and the plates examined *in advance of the practicum*.

*Caution.*—The specimens should not be allowed to dry. Dip them occasionally in alcohol or formalin, or hold them over a dish of it and squeeze some upon them from a pledget of absorbent cotton.

§ 1. *General Topography of the Sheep's Brain.*—Determine the regions and aspects as follows :

*a.* As a whole the brain is obviously symmetric, *i. e.*, composed of right and left halves approximately identical, notwithstanding artificial differences due to injury during removal from the skull or to distortion during hardening.

*b.* The two ends differ, in that one presents a single, mesal or azygous projection, the remnant of the MYEL (spinal cord), while at the other there is a mesal notch between the two OLFACTORY BULBS ; the latter, of course, is the cephalic end, and the former the caudal.

*c.* Of the two remaining aspects, the more regularly convex is *dorsal*, while the *ventral* is irregular and presents several elevations and depressions.

§ 2. Close the eyes, handle the brain, hold it in various positions, and test the prompt recognition of the several regions by the touch.

§ 3. *Great Divisions.*—By a transverse depression the caudal fourth is demarcated from the cephalic three-fourths. The former consists mostly of the CEREBELLUM, the latter mostly of the CEREBRUM. Note that the cerebrum presents a *mesal furrow*, while the cerebellum is *highest at the meson* ; also that the cerebral surface is cut up into tracts, gyres or GYRI, by sinuous furrows, FISSURES, while the cerebellum presents several series of parallel narrow ridges, FOLIUMS, and alternate short furrows, RIMULAS.

*a.* The human cerebellum presents a furrow between two lateral masses, but with most mammals the form is more nearly as in the sheep.

§ 4. Make an outline drawing of the left side of the entire brain, natural size, indicating the following features :

*a.* The irregular ventral outline, which at present serves merely as a base-line for the rest and need not be accurately represented.

*b.* The convex dorsal outline, with its abrupt cephalic and caudal declivities, and the oblique furrow between the cerebrum and the cerebellum.

- c. The caudal projection of the myel.
- d. The slight, cephalic extension of the left olfactory bulb.
- e. The numerous subdivisions of the cerebrum and cerebellum need not be indicated, but the following should be :
  - f. The line separating the foliated cerebellum proper from the OBLONGATA constituting the ventral portion of that region.
  - g. Two or three lines approximately parallel with the main outline of the cerebellum, demarcating the mesal and one or two lateral series of foliums.
  - h. On the cerebral region, a line beginning at the root of the olfactory bulb and extending dorso-caudad to the middle of the length of the cerebrum, then caudad and slightly ventrad. The convoluted mass dorsad of this line is the cerebrum proper, PALLIUM or mantle ; the ventral portion, although sometimes corrugated in parts, is not strictly convoluted, and—from its direct continuity with the olfactory bulb—is called the OLFACTORY TRACT.

§ 5. Make an outline, natural size, of the base or ventral aspect of the brain. Pl. XIX may be employed for comparison, and for ascertaining the names of parts, *but the drawing should represent the specimen.* The following order will be found most available :

a. Represent the meson by a straight line the length of the brain, but light enough to permit portions to be erased later ; then the lateral outlines of the whole and the boundary between the cerebral and cerebellar regions.

b. All the parts and lines already noted from the lateral aspect, the olfactory bulbs and tracts and their lateral boundaries ; the lines between the cerebellum and the oblongata.

c. The PONS, a bridge-like mass whose elevated cephalic margin corresponds with the boundary between the cerebral and cerebellar regions and which, laterad, is evidently continuous with the cerebellum.

d. The mesal furrow upon the cephalic part of the cerebrum is interrupted abruptly by an X-shaped elevation, the CHIASMA. On Pl. XIX is seen that the cephalic diverging arms of the X are continued laterad to the eyeballs ; they are the OPTIC NERVES. The caudal arms, less distinct in the actual specimen, are the OPTIC TRACTS.

e. Between the chiasma and the pons should be a mesal, sub-spherical mass, the HYPOPHYSIS, as shown in Pl. XIX, connected with the base of the brain proper at three or four points ; the most important of these attachments is at the middle of the cephalic border.

In the actual brain any one of the following conditions may exist :

1. The hypophysis may be cut, torn by the saw, or flattened by pressure. 2. The mesal pedicle above mentioned may present an artificial orifice through which preservative was injected into the cavities of the brain. 3. The entire hypophysis may be cut or torn off, leaving a mesal orifice, the LURA, as in Pl. XX.

f. In the interval at either side of the hypophysis is the CRUS, a column-like mass, overlapped laterad by the margin of the olfactory tract, and caudad emerging from entad of the pons.

§ 6. *The Arachnoid.*—The outlines of the parts just mentioned are somewhat vague. If the brain be supported on the fingers of both hands, and the thumbs be placed on the widest and most prominent part of the olfactory tracts (corresponding, on Pl. XIX, to the letters *t o r y* on one side and on the other to the area laterad of the numbers  $\chi$  and  $\delta$ ), and the parts be pressed alternately laterad and mesad, there will be recognized a

sheet of membrane which is alternately tense and wrinkled. This membrane is the ARACHNOID.

§ 7. *The Subarachnoid Space.*—At the (real) left of the hypophysis, with the forceps tear the arachnoid; there will be disclosed an interval between it and the apparent surface of the brain; the SUBARACHNOID SPACE. Note similar conditions in the following localities: (a) In the triangular interval between the crus, the pons, cerebellum, and cerebrum; (b) in the deeper interval between the cerebrum and cerebellum when the latter is tilted caudad; (c) between the two halves of the cerebrum; (d) between the dorsum of the myel and the overhanging cerebellum; (e) between the margins of the olfactory bulbs and the adjacent cerebral surface; (f) along the lines of the principal fissures and rimulas.

Upon the intervening areas the arachnoid may be recognized as constituting the surface, but as adhering closely to what is subjacent.

§ 8. *The Pia.*—After the removal of the arachnoid from the crus at the left of the hypophysis there will be disclosed BLOOD-VESSELS and a fibrous, delicate sheet of tissue, the PIA, which adheres quite closely to the brain substance. To facilitate this examination the hypophysis may now be pulled off. The pia will be seen to follow closely all the contours, and to dip to the bottom of the mesal cleft caudad of the elevation, TUBER, which supported the hypophysis.

a. In the first edition this was called *torus*. *Tuber* is to be preferred as a simple reduction of the name commonly employed, *tuber cinereum*.

§ 9. *The Blood-vessels of the Pia.*—The decided resistance to the removal of the pia at this point is due to the considerable number of vessels which leave it and enter the substance of the brain. With a lens may be recognized the holes (vascular foramina) transmitting these vessels, whence the names given to the triangular area, POSTCRIBRUM and “posterior perforated space.” With less ease, all surfaces denuded of the pia may be seen to be finely punctate, as if by pin pricks, and the ental surface of the pia to present a woolly aspect called TOMENTUM, from the large number of broken vessels; see *Handbook*, VIII, Fig. 4687, and § 11.

§ 10. *The Cranial Nerves.*—Upon the lateral part of the pons is a fibrous cord resembling the optic nerve; it is the root of the TRIGEMINUS (trifacial or fifth), the sensitive nerve of the teeth and skin of the face, etc. If pushed from side to side it will be seen to really emerge from the brain just caudad of the pons or perhaps through its caudal margin; in man it emerges nearer its cephalic margin.

a. The other cranial nerves are smaller and apt to be detached with the pia, but traces of them may be seen at either side of the oblongata. One, the *oculo-motor*, springs from the crus near the mesal cleft; on Pl. XX a short piece of it is shown on one side (the real left, apparent right); on the other the slit left by its extraction is marked 3. Another cranial nerve, the *trochlearis*, is represented on Pl. XXII, 4.

*Note.*—If there is but one brain available, follow the directions in § 11 upon it; if two, upon the second follow the directions in § 12. Adjoining students may agree which they will respectively follow.

§ 11. *Alba and Cinerea.*—With the large scalpel, dipped in alcohol, slice off the dorsal half of the cerebellum, avoiding injury to the cerebrum. The cut surface will present two colors, the ental parts lighter, the ectal darker. The former is the ALBA, composed of fibers only; the latter the CINEREA, consisting of fibers and cells. If the alba does not extend across the meson remove a thin slice until it does. Make a diagrammatic drawing, indicating the general outline and the tree-like branching of the alba toward the periphery.

§ 12. Slice off the caudal third of the cerebellum, avoiding injury to the oblongata, then the cephalic third, avoiding injury to the subjacent parts.

§ 13. *The Cerebral Alba and Cinerea.*—Slice off the dorsal fourth of the cerebrum. Not more than the dorsal fourth should be removed at the first section. The largest available scalpel should be selected, the blade dipped in alcohol, and the cut made with a slow and steady sawing movement. The plane of section should be nearly parallel with the long axis of the cerebrum and if either end is farther ventrad than the other let it be the cephalic.

*b.* On either cut surface note the relations of the alba and cinerea; here, as also in the cerebellum, these are sometimes called more specifically MEDULLA and CORTEX. The cortex forms a continuous ectal layer as in Pl. XVIII, following the fissures.

*a.* The detached areas of cinerea represent portions of the cortex at the bottoms of fissures that open on the dorsum.

*b.* At the ends of the mesal (intercerebral) fissure, note the arachnoid crossing from one hemisphere to the other; near the caudal end is an orifice corresponding to *r* in Pl. XXIII.

*c.* Divaricate the two halves of the removed piece and note that the mesal surfaces are covered by the pia which also dips into the fissures.

§ 14. *Exposing the Callosum.*—On Plates XVIII and XXIII note the location and extent of the CALLOSUM, the great cerebral commissure. Note also on Pl. XVIII the directions of the several oblique surfaces *b* and *c* which are approximately at  $45^\circ$  with the surface *a*.

§ 15. Apply the scalpel across the middle of the length of the left olfactory bulb and slice off the cephalic end of it and of the left cerebrum. If the piece comes off freely or adheres only by the pia, then transect the other at the same level and angle. But if it hangs to the opposite side by any nervous substance, the cephalic end or GENU of the callosum, the right cerebrum and bulb must be cut a little farther cephalad so as to clear the genu entirely. Remove the caudal ends at a similar angle, so as to present the surfaces *c*, and expose the SPLENIUM.

§ 16. The narrow surfaces *d*, at either side of the meson, must be cut with extreme care. From Pl. XXV, especially from the enlargement of part of it, it will be seen that at the bottom of the mesal INTERCEREBRAL FISSURE is a slight lateral extension at either side, the CALLOSAL FISSURE. In making the cuts the object should be to remove the apposed mesal portions of the two cerebrums just to the level of the callosum and as far laterad as the callosal fissures extend so as to expose the free dorsal surface of the callosum in its entire width. The convexity of the tracer may be used to advantage in lifting from the callosum the overhanging edges, and these may be more safely trimmed afterward.

*a.* The oblique narrow surfaces *e* and *f* need no special directions; but even when they are cut, in order to see between the cephalic ends of the cerebrums it will be necessary to divaricate these slightly and to remove the arachnoid and pia, perhaps even a slice of the cortex at either side.

§ 17. *Labeling the Brain.*—Upon a bit of paper as long as the greatest width of the cerebrum and about half as wide, write *with pencil or India ink* (common writing ink is washed out by alcohol) your name, the number of the practicum section (thus Pr. II) and the number of the window (thus, W. VII). With a small pin at either end attach it across the brain about in the position of the word *cerebrum* in Pl. XVIII.

§ 18. *Study of the Encephalic Segments.*—Refer to the lecture in which the segmental constitution of the brain is presented as a fundamental conception of the organ.

§ 19. So far as possible each student should make enlarged drawings of the following preparations. They should be kept wet as directed in the initial Caution.

§ 20. *Frog's Brain, entire, exposed by removing parts of the head on either side.*—The dark disk at the side of the head is the TYMPANODISK (*membrana tympani*), which in this animal is at the level of the rest of the skin since there is no ectal ear; Pract. VI, § 29.

*a.* Recall what was said in the lecture as to the exceptional mesal fusion of the olfactory bulbs in the tailless Amphibia (frogs and toads).

*b.* The real CONARIUM is attached to the cranium and was removed therewith; the dark mesal mass that might be taken for it is a plexus. The caudal region of this brain is obscured by the METATELA; see § 21.

§ 21. *Second Frog's Brain, Lacking the Metatela.*—Only the caudal half of this need be drawn, showing the sides and floor of the large triangular cavity, METACELE (corresponding to the greater part of what is commonly called the "fourth ventricle") and the narrow cerebellum which was hidden in the other specimen by a cephalic protrusion of the metatela.

§ 22. *Dissected Sheep's Brains, such as are Represented in Plates XX–XXII.*—The descriptions of these figures should be studied carefully in advance. The drawings should be *twice* the natural diameter of the specimens and should represent them rather than mere copies of the corresponding figures.

§ 23. After the outlines of the dorsal aspect (Pl. XXII) are made satisfactorily the surfaces may be distinguished as follows:

*a.* The cut or artificial surfaces may be left blank, or the oblique ones shaded slightly.

*b.* The natural surfaces that were covered by pia may be colored *red*.

*c.* The other natural surfaces are covered by the ENDYMA, which lines the cavities and may be colored *yellow*, *e. g.*, the CAUDATUM, its CAPUT and CAUDA, and the HABENA just at the side of the mesal DIACCELE.

*d.* A sharp red line may be employed to indicate the cut edge of a pial or ectal surface, *e. g.*, at the left of the cerebrum.

*e.* A yellow line may represent the cut edge of an endymal or ental surface, *e. g.*, along the lateral margin of the caudatum.

*f.* Where the pia and endymal have been in contact and have been cut or torn away leaving a sharp or ragged edge of membrane, a RIPA, *e. g.*, there should be parallel red and yellow lines.

*g.* The cerebral and cerebellar cortex may be indicated by a slight shading or by a more appropriate gray color.



## PRACTICUM IX. THE MESAL ASPECT OF THE SHEEP'S BRAIN.

PLATES REQUIRED, XXIII, XXV.

§ 1 *Inevitable Imperfection of the Specimens.*—An absolutely perfect condition of both mesal aspects of a medisected brain could only result from the combination of the following conditions :

A. The brain was normal.

B. It was hardened with neither deflection of the long axis nor tilting of the cerebellum to one side.

C. It was divided accurately upon the meson throughout its entire length and height.

a. Reference to Plates XXIII, XXIV, XXV, will show that the chances are against the passage of the knife exactly between the apposed surfaces without cutting either, and against the cutting of azygous parts precisely at the meson. For example, in Pl. XXV, near the center, is a dorso-ventral dark area representing a narrow cavity, the PSEUDOCOELE, bounded at either side by a thin lamina, the HEMISEPTUM. The actual parts are only one-fourth the dimensions in the lower figure. If, instead of bisecting the pseudocœle the knife should pass a very slight distance to the right or left of the meson, then, at that point, in place of two natural surfaces would be two cut surfaces ; and if it should pass still farther laterad, it would open the cavity at the other side of the hemiseptum so that one-half of the brain would present a surface and the other a cavity ; this would be confusing enough, yet it is only one of many possible and even probable conditions.

b. Indeed the happy combination indicated in § 1 has not occurred in the writer's experience. He has found that practically the best plan has been to cut a trifle laterad of the meson, preferably to the left, then to shave off from the right half the parts of the left that adheres to it ; in other words, one-half of the brain is sacrificed to the other.

c. Even with this method the result is uncertain ; the specimens submitted to the class at this practicum have been selected from several hundred. They must be studied in turn by all the members of the class ; hence they should be handled with great care. In lifting place the fingers and thumb upon the ventral and dorsal surfaces respectively ; *make no pressure upon the mesal parts ; keep them, and indeed the entire specimen, constantly wet with alcohol.*

§ 2. The good meson may be either right or left, preferably the former for readier comparison with the wall-maps of the sheep, cat, human and chimpanzee brains and with the figures. But in addition there are a right and a left half-brain, with poor mesons. Even if they are not really mates, *i. e.*, halves of the same brain, they will serve certain purposes in this practicum, and may be handled more freely, but still with care.

§ 3. Appose the mesons of the two half-brains, and review the base or ventral aspect in comparison with Plates XIX and XX. The HYPOPHYSIS has been removed ; in the midst of the TUBER, the slight elevation to which it was attached, is a mesal orifice, the LURA, resulting from cutting or tearing off the stem of the hypophysis.

The lura leads dorsad into a shallow depression in the mesal surface, (Pl. XXIII, *diacœle*), indistinct in one, perhaps both, of the poor half-brains, but more or less distinct in the good preparation. Trace this depression dorsad and then candad, and note that in the region of the

GEMINA, the MESENCEPHAL, its depth, *i. e.*, its lateral diameter, is somewhat greater, while its dorso-ventral diameter is less ; it is thus a furrow, and of course with its opposite constitutes a sub-cylindrical tube, the MESOCŒLE, often called the *aqueduct*. Its relation to the gemina may be seen also in the transection of this region, corresponding with the line D-D across Pl. XXIII.

§ 4. The detailed study of the encephalic meson may conveniently follow this order :

- a. Recognizing the larger masses.
- b. Recognizing the six segments.
- c. Determining the continuity of the mesal cavities.
- d. Determining the complete circumscription of the cavities.
- e. Discriminating between the several kinds of surfaces and cut edges.
- f. Drawing the specimen in hand.
- g. Comparing the parts visible at the meson with the same as seen in transections ; to be done at Pract. XI.
- h. Comparing the mesal aspect of the sheep's brain with that of man and other animals.

§ 5. *Prominent Parts.*—At Pract. VIII were seen the CEREBRUM, CEREBELLUM, OLFACTORY BULB, PONS, CHIASMA and HYPOPHYSIS ; also, upon removal of the dorsal part of the cerebrum, the mesal part of the CALLOSUM.

§ 6. *The Segments.*—a. The entire cerebellum, pons and preoblongata (cephalic part of the oblongata) constitute the EPENCEPHAL.

b. The rest of the oblongata, postoblongata, is the METENCEPHAL.

c. The MESENCEPHAL includes the crura, postgeminum and pregeminum.

d. The DIENCEPHAL is represented by the hypophysis and adjacent parts, the conarium and adjacent parts, and the medicommissure connecting two considerable masses, the thalami, seen in Pl. XXII.

e. The cerebrum constitutes the PROSENCEPHAL.

f. The *Rhinencephal* comprises the olfactory bulbs and their crura ; also parts of the olfactory tracts, of the precommissure and of the aula which are commonly regarded as constituents of the cerebrum.

g. The segmental constitution of the brain is discussed in the lectures on the development of the organ : See *Anat. Technology*, p. 405 and *Handbook*, VIII, p. 114 and IX, p. 101, for admissions of the modification of the writer's views upon the subject.

§ 7. *The Mesal Cavities.*—These are indicated on Pl. XXIII by the darkly shaded area ; their forms are more fully exhibited in *Handbook* Fig. 4703.

a. The cavity of the myel is a slight, cylindrical canal, the MYELOŒLE (not named in Pl. XXIII).

b. The METACŒLE is slightly higher and (as will be seen later) considerably wider.

c. The EPICŒLE has a marked dorsal extension into the cerebellum.

d. The MESOCŒLE is tubular but curved and somewhat irregular.

e. The DIACŒLE, surrounding the medicommissure, is irregular, narrow, but extensive in the other directions.

f. In this view of the brain the PROSOCŒLE is represented only by the AULA, a small space cephalad of the medicommissure, at the dorsal end of the slight, curved furrow named AULIX. But if the preparation be held obliquely there will be seen a narrow passage, the PORTA, leading latero-cephalad into the PARACŒLE (lateral ventricle) of that side ; this will be exposed at the next practicum.



g. Small as is the aula a part of it constitutes the mesal division of the *Rhinocœle*, the larger portions being hidden within the olfactory bulbs.

§ 8. *Cœlian Parietes*.—The walls of the brain cavities, ventral, lateral, and dorsal, are comparable with *floors*, *sides* and *roofs*.

a. Beginning with the mesocœle the crura constitute a substantial floor. At the meson the roof is of moderate thickness, but at either side the geminal lobes are massive.

§ 9. The preoblongata is reinforced by the pons. Part of the epicœle is a dorso-ventral extension into the massive cerebellum. But if the cerebellum be tilted slightly laterad (more freely is the extra half-brain), its cephalic part will be seen to overhang a thin lamina, the LINGULA, which is the true roof of the cephalic part of the epicœle, and which is continuous with the VALVULA, a similar thin portion of the mesocœlian roof.

§ 10. The floor of the metacœle is obvious. Its roof is even thinner than the lingula. If the cerebellum of the extra half-brain be tilted latero-cephalad there will appear a membranous sheet, continuous caudad with the roof of the myelocœle, and cephalad attached to the cerebellum at some point on the caudal wall of the dorsal extension of the epicœle. This METATELA consists of the PIA, which follows the ectal contour of the parts, united with the ENDYMA that lines the cavities.

§ 11. The diacœlian floor is variously constituted. The TUBER, to which the hypophysis is attached, is thin; but caudad is the prominent ALBICANS, and cephalad the CHIASMA; dorsad of the chiasma is another thin portion, the TERMA (*lamina terminalis*). The terma is so thin that even when it has escaped injury in the medisection of the brain it may not be readily recognized unless three points are borne in mind: 1. Its direction is dorso-caudad; 2. It starts from the dorsal surface of the chiasma rather nearer its cephalic margin than is represented in Pl. XXIII; 3. Dorsally it is continuous with a distinctly oval thickening, the PRECOMMISSURE, opposite the middle of the MEDICOMMISSURE.

§ 12. The diacœlian roof is irregular in direction and varies in composition, and will be most easily traced from the end next the mesencephal. The conarium has already been recognized (§ 6) between the pre-geminum and the SPLENIUM, the caudal end of the CALLOSUM. By gently moving its caudal end, its ventro-cephalic angle will be found to be continuous with the mesocœlian roof by a curved and corrugated lamina, the POSTCOMMISSURE. Just dorsad of this is a short triangular recess in the substance of the conarium. If the parts are examined closely, especially with a lens, the opposite boundary of this recess will be recognized as a subcylindrical lamina, the SUPRACOMMISSURE. Just dorsad of this will be seen a membrane, the DIATELA, represented in Pl. XXIII by a white line. Really the ventral ental surface of the diatela presents a series of ridges constituting a fringe, the DIAPLEXUS. Traced caudad the diatela will be found to form a sort of pouch on the dorsal side of the conarium; it appears to be attached near its tip, as shown in Pl. XXIII, but may commonly be detached nearly or quite to the supracommissure. Traced cephalad the diatela will be found loosely attached to the parts dorsad of it until, at a point dorsad of the middle of the medicommissure, it is no longer separable easily.

§ 13. *The Lateral Boundary of the Dorsal part of the Diacœle*.—Excepting, perhaps, the metacœle the cavities so far inspected present not

only floors and roofs but definite and continuous sides. But the middle portion of the dorsal part of the diacœle seems, at first sight, to extend laterad indefinitely upon the dorsum of the thalamus, and if the student is already aware that each cerebrum contains a cavity, the paracœle (lateral ventricle), he may well infer that here is a direct communication therewith.

Since this idea is rank morphologic heresy, the parts should be examined very carefully.

§ 14. Hold the less perfect extra half-brain in the left hand; press the left thumb firmly against the mesal surface of the mesocœlian floor (Pl. XXIII *crura*); place the tip of the scalpel handle (or similar smooth, dull instrument about 1 cm. wide) ventrad of the middle of the diatela, and press it against the parts dorsad of it; increase the pressure very cautiously until it can be seen that, at the distance of 2-3 mm. from the meson, the *diatela unites with the dorsum of the thalamus and the diacœle is there limited*; compare Plates XXII and XXV.

a. But when this line of attachment is traced cephalad it will be found to cease dorsad of the cephalic slope of the medicommissure. From this point cephalo-ventrad nearly to the level of the precommissure there is evidently a passage extending laterad; this is the PORTA, (foramen of Monro) and the cavity into which it leads is the PARACœLE (lateral ventricle) to be examined later. The mesal cavity between the two portas is the AULA, the small mesal division of the prosocœle, the general cavity of the prosencephal; see Handbook Fig. 4703. The roof of the aula is not the diatela but the mesal part of the FORNIX, *fcu.* in Pl. XXIII, to be examined later.

§ 15. *The Crista*.—Just dorsad of the precommissure is a slight rounded elevation, the CRISTA. If the plane of section has coincided with the meson it will appear as in Pl. XXIII; but it has passed sinistrad of the meson, with a right half it may remain entire.

§ 16. *The Habena*.—Just cephalad of the conarium is a low ridge, widest and most distinct caudad, but becoming both narrower and fainter it extends dorsad, cephalad and laterad along the dorsal slope of the thalamus; this is the HABENA. If the supracommissure is examined with the lens it will be seen to be a transverse band connecting across the meson the dorsal parts of the caudal ends of the two habenas.

§ 17. *Cœlian Circumscription and Endymal Continuity*.—From the examination just concluded it may be seen that the mesal series of cavities is circumscribed by continuous parietes, floors, end, roof and sides, covered by the lining endyma; also that this circumscription would still be maintained even were most of the cerebrum and cerebellum removed.

§ 18. *The Surfaces that Appear upon the Mesal Aspect*.—The two kinds are *natural*, and *artificial* or cut. The roof of the mesocœle furnishes an example of each. The shaded area represents the mesal slope of a lateral convexity, the right half of the pregeminum. The unshaded area just dorsad of the mesocœle represents the depressed roof between the lateral masses, which was divided by the medicsession. All the other unshaded areas represent cut surfaces; *e. g.*, cerebellum, medicommissure, hypophysis, *etc.* Certain parts that are distinctly fibrous are indicated by dots, *e. g.*, the callosum, pons, chiasma.

The divisions of the cerebellum (folium) are not shown, and neither here nor else, where has the CINEREA (gray nervous substance) been distinguished from the ALBA, excepting that the fibrous parts indicated by dots are of course alba (white nervous substance). The color difference between the alba and cinerea does not appear distinctly upon alco-

holic specimens; the distinction of the two kinds of substance may be observed to better advantage upon brains hardened in formalin or in potassium dichromate, to be examined at Pr. XI.

§ 19. With one exception (to be considered presently) the natural or uncut surfaces are of two kinds: *endymal*, ental or entocœlian, and *pial*, ectal or ectocœlian.

*a.* The first includes all the true encephalic cavities whose circumscription has been traced already (§ 8). The lining membrane is smooth and in certain lights shining. The difference between the endymal surface and a cut surface may be seen by comparing the medicommissure with the slightly depressed area surrounding it.

*b.* The triangular, shaded area just ventrad of the cephalic three-fifths of the callosum represents the HEMISEPTUM, the lateral wall of the narrow mesal cavity, pseudocœle (fifth ventricle). This cavity has no normal communication with the true encephalic cavities, and is cut off from the ectal, pial surfaces by the pia which extends from the *rostrum*, the tip of the callosum, to the crista; so far as the writer is aware no membrane of any kind has been recognized upon the surface.

*c.* All the other natural surfaces are covered by pia. For its character and relations see Pract. VIII, § 8. If time permits it may be traced over all the parts, in close contact with them.

§ 20. *The Cut Edges of Membranes.*—The cut edge of the endyma is indicated on Pl. XXIII by the continuous black line at the ental margin of all the divided parietes. So much of the endyma, however, as constitutes the ental layer of the diatela is represented by the corresponding half of the light line. The pial edge corresponds, for the most part, to the ectal margin of all the divided parietes. In the metatela it and the endyma are practically one. On the lingula, valvula and terma it is not easily separable without tearing those attenuated parts. Opposite the middle of the medicommissure, instead of following the line of the immediate roof of the cavity, it is deflected to the tip of the callosum, the rostrum, passes over the genu, along the dorsal side of the callosum, dipping into the callosal fissure. It then passes about the splenium to the ventral side of the fornix (*fcm.*) continuing as far cephalad as the point where the diatela ceases to be attached, the dorsal end of the porta (§ 14, *a*). Here it turns upon itself, and becomes united with the endyma to form the diatela.

§ 21. *The Velum.*—From the foregoing it will be seen that between the diacœle and the ventral surface of the fornix and splenium there are two layers of pia, continuous cephalad but diverging caudad. One belongs to the diencephal, the other to the overhanging cerebrum; the two layers of pia, with the vessels between them, are commonly called the VELUM, but it must not be forgotten that the closer junction of the ventral layer with the endyma constitutes the diatela. The relations will be clearer when Pl. XXV is studied.

§ 22. *Drawing the Mesal Aspect.*—The specimen in hand is to be drawn, enlarged two diameters. Pl. XXIII and the foregoing text may be used for reference and comparison, *but the figure is not to be copied.* The following method will be found convenient:

*a.* Support the specimen in a small dish or upon a bed of cotton, (or cloth, or Japanese napkin) so that the meson is nearly at an angle of  $45^{\circ}$  with the table and thus nearly at a right angle with the line of vision. Let the length of the callosum be nearly horizontal.

*b.* Keep the specimen wet with alcohol. If by inadvertence it act-

ually becomes dry, call the assistant's attention to it, and immerse in water for a few moments.

*c.* Make four light horizontal and parallel lines twice the length of the brain, coinciding respectively with the dorsal convexity of the cerebrum, the ventral convexity of the pons, the dorsal margin of the callosum and the ventral margin of the mediodorsal commissure. At right angles to these make three perpendicular lines coinciding respectively with the cephalic convexity of the cerebrum, the caudal convexity of the cerebellum and the caudal margin of the mediodorsal commissure. The intermediate line will be very nearly in the middle of the length of the brain. By measuring with the dividers double the distance of any point from the places of intersection considerable accuracy may be attained.

§ 23. The cavities should be outlined first and fully their natural dimensions, twice enlarged; that is, since these spaces at most are rather slight, while the encompassing masses are considerable, the latter may be diminished with less risk of obscurity in the drawing.

*a.* The callosum and mediodorsal commissure should be outlined first; although often nearly circular, as in Pl. XXIII, the latter is by no means always so, being sometimes oval or elliptical.

*b.* Next the floor of the mesal cavities; if as is commonly the case, the hypophysis has been removed, it may be omitted or copied from the figure.

*c.* Then the roof of the mesocœle; the ental line should be sharp and clear to represent the endyma, the ectal line of the cut surface not quite so heavy, but distinct, to represent the pia. The convex outline of the geminums should be light, and the intervening pial surface indicated later by light shading. If the three kinds of surfaces—cut, pial and endymal—are not at first easily discriminated, hold the specimen so that the light strikes successively at different angles.

*d.* Next the thin lamina, valvula and lingua, roofing in the communicating portions of the mesocœle and epicœle. Observe the caution given in § 9 and get these parts from the less perfect specimen; their precise thickness may not be worth taking time to ascertain, but the two lines representing the pial and endymal coats of the lingua should be about as near together as they can be and yet be distinguishable.

*e.* The myelocœle (central canal of the myel) is seldom visible for any distance in medisectioned brains unless special pains have been taken to expose it; if the section has passed to the side opposite that to which the specimen belongs, the continuation of the metacœle with the myelocœle may sometimes be seen as a funnel-shaped orifice by looking obliquely latero-caudad at the extremity of the metacœle; the presumed continuation may then be represented by two parallel, interrupted lines.

*f.* The membranous metatela (§ 10) is shown in Pl. XXIII as a single line representing the union of the endyma with the pia which is reflected from the dorsum of the myel upon the ventral surface of the overhanging cerebellum; the place of reflection is located in the figure at the angle between the ventral surface of the cerebellum and the dorsal extension of the epicœle; but in some—perhaps most—specimens the membranous lamina may be traced for some distance dorsad of this angle; there may not be time to ascertain the condition in the specimen, but any doubt may be recorded.

*g.* The dorsal extension of the epicœle should be given its full width or even more.

§ 24. The mass of the cerebellum may now be outlined. Unless there is plenty of time a single line, as in Pl. XXIII may suffice. But if



there is opportunity for elaboration later, there may be introduced some of the foliums between which the pia dips in folds; the first outline might then represent the arachnoid which, as seen in Pract. VIII, passes over the rimulas, bridges the interval between the cerebellum and the cerebrum not far dorsad of the pregeminum, and passes from the caudal convexity to the myel.

*a.* If preferred, as in Pl. XXIII, the cerebellum may be represented as if tilted caudad enough to exhibit more clearly the interval between it and the cerebrum, but as this would involve shifting the oblongata also, the same end may be attained by diminishing the width of the cerebellum somewhat, or by reducing the length of the cerebrum; the exactitude of these dimensions is not essential for the purpose of the present examination.

§ 25. The cut surfaces of the conarium, postcommissure and supra-commissure may be outlined next; the conarium may be made a trifle smaller than it should be in case, later, room is lacking between it and the overhanging callosum to show clearly the diatela as resulting from the junction of the diacelian endyma and the ventral layer of the velum, and also the dorsal layer of pia which adheres to the callosum and fornix (§ 20).

*a.* Besides the fringe-like diaplexus referred to in § 12 there may appear the whole or part of the mesal *velar vein* (Pl. XXV) which passes between the two layers of the velum and opens into a blood-sinus, the depression caused by which is indicated in Pl. XXIII by the shaded tract, *r*, just caudad of the splenium. It may be better not to try to show this vein.

§ 26. The heavy line representing the endyma should be continued from the dorsal end of the porta (at about the letters *fcm.*) with slight undulations to represent the crista and precommissure, to the chiasma and so back to the tuber.

§ 27. The ectal or pial outline of the parts just named present no serious difficulties, but care must be taken to discriminate between the mesal cut surface of the chiasma and the retreating pial surface of the optic nerve. The terma must be represented, like the lingula, by two barely separated lines, diverging dorsad at the precommissure. At or near the crista the pia makes a sharp turn cephalad to the rostrum and extends dorsad of the callosum, while the outline of the fornicommissure extends in the opposite direction.

§ 28. The fibrous constitution of parts like the callosum and pons may be indicated by dots. In some, even alcoholic, preparations, the cut surface of the cerebellum may present traces of the color difference between the *alba*, radiating from near the epicæle as larger and smaller branches and fringes, and the *cinerea* constituting a rather thin cortex at the periphery of the foliums; if so the cinerea may be shaded lightly.

§ 29. The mass of the hemicerebrum, which might naturally have been drawn first, is to be last done, together with the olfactory bulb. The fissures may be shown as lines, preferably red, to indicate the folds of vascular pia that dip into them. Strictly, the callosal fissure also should be so represented, but if so, just ventrad of it the cut edge of the pia crossing the meson should appear as a narrow black line.

§ 30. *The Arachnoid.*—Since, as seen in Pract. VIII, §§ 6, 7, the arachnoid bridges the intercerebral fissure, leaving the mesal surface of

either cerebrum near its dorsal margin, its cut edge should be shown as a delicate line along the curvature ; it may be seen more distinctly if the specimen be placed in alcohol or water deep enough to just cover the meson. The writer has not yet traced completely the arachnoid line upon a medisectioned brain.

§ 31. *Shading*.—When the outlines are satisfactory then the natural surfaces, both pial and endymal, may be lightly shaded, the recesses and intervals more heavily, approximately as in Pl. XXIII. All the cut edges of pia and endyma should be shown as distinct lines.

§ 32. *Continuity of Membrane Lines*.—The continuity of the endyma has been mentioned in § 17 ; the same is true of the pia ; *i. e.*, starting from any point, the pia may be traced caudad to the cut end of the myel ; then cephalad, and dorsad or ventrad as the case may be, and again caudad to the other margin of the myel.

§ 33. *Coloring*.—This endymal and pial continuity may be more readily recognized upon the drawing if the cut edges of the endyma are represented by yellow lines and those of the pia by red. The fissures also, as containing folds of the vascular pia, may be made red ; if so, the extent of the callosal fissure may be indicated by a thickening of the red line corresponding therewith. The metatela and diatela will require red and yellow lines in contact.

§ 34. *Comparison of the Mesal Aspect of the Sheep's Brain with that of Man*.—For this purpose there should be actual specimens, prepared in the same way as the sheep half-brains ; but the difficulties presented by the sheep brain are far greater with the human ; indeed the writer has never seen an even approximately perfect preparation. The best specimens in the museum are represented in Handbook figures 4684, 4711 and 4718 ; copies of the first and third are supplied to the class ; see also the wall-map enlargement of the first.

§ 35. The student should note for himself, as concisely as possible, the more obvious differences in proportion, relative position, form, *etc.*, beginning with those of a more general character. The fissures need not be considered.

The following differences might escape notice from the imperfections of the figures, but they merit attention as relating to known or presumed peculiarities of the human brain, shared in some cases, perhaps, by those of the apes :

a. The interruption of the metatela, constituting the metapore ; this is considered in the description of the figure ; see Handbook Fig. 4719 and Vol. IX, Fig. 422.

b. The presence, on the dorsal side of the lingula (§ 9) of three or four ridges, indicated in the figure by the serrated outline ; see Handbook Fig. 4719 and Vol. IX, Fig. 422.

c. The smallness of the medicommissure in man ; most of it is covered by the word *diencephal* ; see Figs. 4711 and 4718.

d. The extension of the rostrum of the callosum so as to be continuous with the terma just dorsad of the precommissure, thus completely circumscribing the pseudocœle by nervous tissue ; this is clear in Figs. 4711 and 4718, but in Fig. 4684 the extension, *copula*, is obscured by names.

e. The olfactory bulb and crus are hidden by the depth of shading, but their smallness may be seen in Figs. 4718 and 4689.

f. In man there are two albicantia, as seen in Figs. 4689, 4712 and

4728. Hence a medisection passes between, and the retreating convexity of the right one should appear as shading, as in Fig. 4711.

*g.* Between the dorsal portions of the two hemicerebrums projects a fold of dura, the *falx*, Fig. 4711. This carries before it the arachnoid and hence the cut edges of the latter follow the ental margin of the falx instead of lying near the dorsal margin ; it is faintly indicated in Fig. 4684 by the interrupted line 5.



§ 1. At the best the time available at two ordinary practicums is altogether inadequate for the demonstration and comprehension of the macroscopic structure of the brain. All the exercises should be repeated when opportunity offers. Upon the transections many hours may be profitably spent.

§ 2. For reference during this practicum and the next there should be a good mesal aspect, as in Pl. XXIII, and preparations such as are shown in Plates XX-XXII and XXIV.

a. If two brains are available one may be dissected as directed below and the other transected at the levels indicated by the dorso-ventral lines A—G upon Pl. XXIII, and elsewhere if desired.

b. If two students are working together and have each a brain, one may be used for the transections; of the second brain the left paracœle may be exposed by one and the right by the other; the non-dissector should watch and cooperate.

c. With modifications that need not be specified the following directions apply to either half of a medisectioned brain.

d. Wherever the tracer is mentioned in this practicum the syringotome would be preferable; Anat. Technology, Fig. 15; Ref. Handbook, VIII, Fig. 488o.

§ 3. *The Cerebellum*.—From this may have been removed already either the dorsal portion or the cephalic and caudal convexities, or all three (Pract. VIII, §§ 11, 12). On the lateral aspect, overhanging the pons note several series of foliis. With the tracer push them dorsad. They will easily break away from a stem of alba which is continuous ventrad with the pons and extends dorso-caudad into the central alba of the cerebellum. This stem is the MEDIPEDUNCLE, designated in Pl. XXI by 7, but the number is very indistinct.

§ 4. *The Metatela*.—Depress the postoblongata and push the caudal part of the cerebellum dorso-cephalad. If this is done cautiously and the brain has been well prepared, there will be seen the METATELA, the membranous roof or the metacœle, Pract. IX, § 10, § 23 f. But often it adheres to the cerebellum so as to be torn more or less.

§ 5. *The Lingula and Valvula*.—These are to be exposed by tilting the cephalic part of the cerebellum caudad, Pract. IX, § 9, and 23, d; they too may be torn in the process; but if now the cerebellum be cut off almost at the level of the oblongata the entire metepicœle (fourth ventricle) will be exposed, and by blowing from its caudal portion the lingula and valvula may be demonstrated satisfactorily. There may also be seen the apex of the metacœle where it narrows to become continuous with the myelocœle; also the lateral extensions of the cavity referred to in § 7, a.

§ 6. *The Other Peduncles*.—The prominent ridges at either side of the valvula are the PREPEDUNCLES, connecting the cerebellum with the geminums. The POSTPEDUNCLES, extending ventrad and caudad to the oblongata, are not distinct in the sheep; see Handbook Fig. 4721. The GEMINUMS have been seen in Pract. VIII, Pl. XXII. Sometimes on one or both sides there remains the slender TROCHLEARIS nerve (Pl. XXII) meeting its opposite in the valvula.

§ 7. *The Flocculus*.—Of the short series of foliis mentioned in § 3 the two farthest ventrad constitute the *flocculus*. To isolate it, the tiers farther dorsad must be torn away as directed in § 3. If it is pushed caudad it will be seen to have a slender stalk of its own connected with the caudal margin of the medipeduncle.

a. For details respecting the flocculus and the cerebellum see Dr. B. B. Stroud's paper in the *Jour. of Comp. Neurology* for June, 1895.

*b.* Just caudad of the flocculus and peduncle is a tufted plexus which covers (and probably closes) a lateral extension of the epicœle. The relation and significance of these parts are still under investigation; meantime consult Handbook Fig. 4702 and Vol. IX, p. 616. If, as held by some, these lateral recesses open into a subarachnoid space, the general statement in Pract. IX, § 17, must be qualified accordingly.

§ 8. *Opening the Left Paracœle* (lateral ventricle).—This is most safely accomplished in its cephalic portion, the PRECORNU, where there is but one mass that may be unintentionally injured by cutting too deeply.

*a.* If the cerebrum has not been sliced off as directed in Pract. VIII, §§ 13–16, Pl. XVIII, it should be now.

*b.* Before making any of the incisions here directed the scalpel should be dipped in alcohol.

*c.* Note the location of the cephalic end, GENU, of the CALLOSUM, Plates XVIII and XXIII, and bear in mind (1) that the cavity to be opened is nearly at its level; (2) that it is nearer the mesal than the lateral margin of the hemicerebrum; (3) that the near proximity of the cavity may be recognized by the appearance of a dark area 2–3 mm. in diameter about one-third of the way from the meson to the lateral border. This dark area is not due to a difference in the color of the mass, but only to the existence of the cavity.

*d.* From the cephalic slope of the left hemicerebrum (Pl. XVIII *b*) cut a triangular slice, the thicker end including a part of the surface *a*, the thinner approaching the OLFACTORY BULB, but not quite reaching it. If this does not open the cavity, or expose the dark area mentioned in (*c*), remove a second but thinner slice, and, others if necessary till the precornu is opened.

*e.* From Fig. 3, p. 69, and the dotted lines in Pl. XXIV, note that the precornu is continuous with the cavity of the olfactory bulb, but defer the demonstration for the present; Pract. XI, § 8.

*f.* Remove the "corner" between the surface *a* of Pl. XVIII and the new surface *b* so as to expose the cavity a little farther caudad. Introduce the tracer cautiously a few millimeters only and note that there is a shallow cavity bounded by a roof and floor.

*g.* Carefully avoiding cutting the floor, remove successive thin slices farther and farther caudad till the floor of the exposed cavity presents the appearance shown in Pl. XXIV. It may be necessary to remove a wedge-shaped slice from the caudal end, *c*, and to use the scissors carefully at the mesal side of the cavity.

*h.* Since the cephalic part of the cavity extends not only laterad but also ventrad there is a natural temptation to open the ventral extension near the meson; for the present this should be avoided.

§ 9. *The Paraplexus*.—In the middle of the floor of the paracœle is a vascular fringe, perhaps lying flat as in Pl. XXIV, perhaps in a more compact roll. This is a fold of pia, with blood-vessels, all covered by endyma, and constituting the PARAPLEXUS. How it gets into the paracœle is discussed in the lectures; later in this practicum (§ 21) its relation to the velum will be shown. For convenience, at this stage, on the left side so much of the paraplexus as can be seen should be trimmed closely to its line of attachment, *but not pulled upon*.

§ 10. *The Paracœlian Floor*.—The removal of the paraplexus exposes the more substantial constituents of the floor, as seen in Pl. XXIV. Cephalad is the pear-shaped CAUDATUM, the convexity of which really looks quite as much mesad as dorsad. Farthest caudad is the HIPPOCAMP (*hippocampus major*). Between it and the paraplexus is a less distinct elevation, the FIMBRIA.

*a. The Cella.*—The largest portion of the paracœle corresponds to what has been called the *CELLA (cella media)*; see Handbook Figs. 4703, 4740, 4746, Vol. IX, fig. 61, and the preparations and photographs. In man there are three extensions of the cella: cephalic, *PRECORNU*, ventral, *MEDICORNU*, and caudal, *POSTCORNU*; the last is wanting in the sheep as in most other mammals. As to the human paratela, see  $\frac{1}{2}$  21, *f*.

§ 11. *The Medicornu.*—At the caudal end of the paracœle there is evidently the beginning of a ventral extension, the *MEDICORNU*. Introduce the tracer for a few mm., on the left side, and remove a slice of the caudal end of the hemicerebrum; by constantly "feeling one's way" and removing thin, wedge-shaped slices, it will be possible to follow this horn-shaped extension of the paracœle ventrad, laterad, cephalad, and at last even slightly mesad to the extremity of the elevation on the ventral aspect of the brain which overlaps the optic tract and is numbered 4 in Pl. XIX.

*a.* The complete exposure of the medicornu will involve cutting away a considerable part of the caudal and lateral portions of the hemicerebrum, as indicated in Pl. XXIV. The convexity of the tracer may be used in pushing up the overhanging edges of the parietes so that they may be more easily cut away with the scalpel or in some cases the scissors. Toward the ventral end, the tip of the medicornu, especial care must be taken not to pull or push upon the parts lest they break at some of the thinner places.

*b.* It will be found that the hippocamp is not regularly convex as indicated by Pl. XXIV, but flattened slightly in places, and terminates as a blunt point at the tip of the cornu.

*c.* The fimbria maintains a nearly uniform width and surface.

*d.* The paraplexus continues to near the tip, and should be trimmed closely, as directed in § 9, but *without pulling upon it*.

*e.* The caudatum, as already seen (§ 10), tapers caudad; there seems to be some difference among the brains as to the extent of its *CAUDA* along the medicornu. In the sheep the writer has not as yet recognized the tenia of the human brain; *Handbook VIII*, 145.

*f.* Note that in potassium dichromate specimens, the fimbria and hippocamp are light (*alba*) while the caudatum is dark (*cinerea*).

§ 12. Make a drawing of the dissection at this stage from the lateral and ventral aspects. In combination with Pl. XXIV they will illustrate the notable changes in the direction or the cavity; it extends successively caudad, laterad, ventrad, cephalad and mesad.

§ 13. *Transecting the Right Medicornu.*—In accomplishing this there is to be removed a mass representing approximately the ventro-latero-caudal eighth of the right cerebrum; on Pl. XIX the piece is bounded as follows: Laterad and caudad by the general outline; mesad by the S-shaped mesal border of the olfactory tract, along the numbers 3, 4 and 6; cephalad by an imaginary line drawn latero-dorsad from the chiasma. The two incisions required to dislodge this piece are to be made as follows:

*a.* Hold the brain with the myel away from you and the ventrum uppermost. With the scalpel point, from the depressed area just laterad of the chasma (Pl. XIX, 3), cut laterad and very slightly cephalad across the olfactory tract and into the pallium for about the same distance, stopping at the greatest lateral convexity of the cerebrum.

*b.* Turn the brain so that the right side is uppermost. Dip the scalpel in alcohol. Begin at the caudal margin of the cerebrum opposite the flocculus. Push the point in for at least 2 cm. (nearly an inch) and cut with a sawing movement to the lateral end of the first incision.

c. If the caudal end of the part ventrad of the incision be gently elevated it may be detached; the operation should be performed slowly and the scissors used promptly for dividing any vessels that may resist the separation; all pulling should be avoided.

d. The detached piece is to be wet with alcohol, and handled with great care, for reasons that will appear presently.

§ 14. From the undulating surface exposed by its removal remove the tough and adherent pia, beginning at the margin of the pons, and note that at the cephalic margin of the optic tract it ceases by an irregular edge, evidently torn. Compare the denuded parts with Pl. XXI where, however, everything is reversed, since it represents the left side.

§ 15. Examine the concave mesal surface of the detached piece, handling it as little as possible and note that its natural surfaces are also covered by pia; defer the removal of the pia till the cut surface has been examined.

§ 16. On either cut surface (more conveniently on that of the detached piece) the following features may be observed and a drawing made if time permits.

a. Not far from the middle of the length, but nearer the mesal than the lateral surface, a crescentic slit, its convexity directed laterad; from comparison with the left side this can be nothing else than the transected MEDICORNU.

b. The lateral wall of the cavity is constituted by the general mass of the ALBA, but the convex mass at its mesal side is mostly CINEREA, with a cephalic edge of alba. Comparison with the floor of the left medicornu shows that these are respectively the HIPPOCAMP and the FIMBRIA.

c. The cortex at the lateral side of the section may be traced caudad over the end of the hemicerebrum to the mesal side, with the usual undulations at the fissures. For a short distance on the mesal side near the caudal end it is thin, but thickens suddenly at the hippocamp.

d. Opposite the cephalic portion of the cut end of the hippocamp is a slit which may be traced to the ventral end of the piece; this is the HIPPOCAMPAL FISSURE, probably the most constant of all the mammalian fissures and one of the earliest to appear in development.

e. The alba forming the central part of the general section is thin in the caudal part of the roof of the cornu, thickens somewhat just caudad of the cornu, on the ental surface of the hippocamp becomes so thin as to be hardly recognizable, but constitutes the whole of the fimbria.

§ 17 It appears then that the hippocamp and fimbria are simply specialized parts of the paracelian parietes, but with inverse proportions of the two constituents; the former consists mostly of cinerea, being thus properly a cortical part; the latter consists wholly of alba, being thus a medullary part; Pract. VIII, § 13.

§ 18. *The Rima.*—As has doubtless been observed already, along the cephalic margin of the fimbria is a crevice between it and the surface that broke away when the piece was detached. This is the RIMA (part of the "great transverse fissure").

§ 19 Under favorable conditions, if the piece is manipulated so as to put the mesal surface slightly on the stretch, the following points may be observed:

a. The rima will be widened especially near the cut end.

b. At the other (ventral) end it ceases a few mm. from the extremity, although a rupture easily occurs so as to extend the natural crevice.



c. At one or more points in its course there are membranous adhesions of the margins of the rima.

d. These adhesions are more apt to persist in brains hardened with alcohol, especially if the cavities have been filled with the preservative.

e. Within the medicornu is a membranous, vascular lamina, the PARAPLEXUS, already seen on the left side (§ 9). It commonly rests closely against one of the walls, but may be separated therefrom with the tracer or a stream of air. One edge is free; the other reaches the rima and is there connected with its margins.

§ 20. If now the pia be removed from the mesal surface of the piece, beginning at the caudal margin, it will be found to dip into the hippocampal fissure as a fold, and then to continue over the fimbria to the rima where it connected with the paraplexus. At the rima or just cephalad of it, however, it was torn when it was removed; otherwise it would be found to be reflected caudad upon the optic tract, *etc.*

a. The piece may now be bent so as to open the rima widely and expose the cornu and plexus. The latter will be found to cease at about 5 mm. from the extremity of the piece. A careful examination, especially of an alcoholic preparation, would show that the rima also ceases there, and that its apparent extension is also due to the rupture of the thin wall.

§ 21. The relation of these parts and their interpretation from embryology and comparative anatomy are considered more fully in *Anatomical Technology*, § 1312, and in the *Handbook* VII pp. 118 and 144. Here it can only be stated that, notwithstanding the ease with which the margins of the rima may be separated in preserved specimens, the dissection of fresh brain and the study of sections of hardened ones leave no doubt respecting the following points:

a. Between the overlapping parts of the cerebrum and the geniculums, *etc.*, are two layers of pia, one belonging to the diencephal, the other to the prosencephal.

b. These two, with the vessels between them, constitute the velum.

c. Were there no rima, the continuity of the two apposed layers of the velum would be along the cephalic margin of the optic tract, at the boundary between the two segments.

d. The interruption of the continuity of the wall of the paracœle, from the dorsal end of the porta to near the tip of the medicornu, constituting the rima, permits the entrance of the margin of the velum into the paracœle as a paraplexus.

e. The paraplexus carries before it the lining endyma, which therefore, although extended over the plexus, connects the two margins of the rima, and thus maintains endymal continuity and cœlian circumscription; Pract. IX, § 17.

f. In the human adult the rima is 1—2 cm. wide at the middle of its length, tapering at the ends. The interval is closed, however, by the apposed endyma and pia, constituting the PARATELA. Through this thin, translucent strip appears the subjacent thalamus, to which it sometimes adheres; this has given rise to the statement current in works on Descriptive Anatomy that the thalamus enters into the composition of the floor of the "lateral ventricle." A similar condition exists in apes. But in the human fetus, up to four months at least, the rima is narrow as in the sheep and most other mammals. See the figures referred to in § 10 a, also Fig. 4749, and the writer's paper, "The relation of the thalamus to the paracœle," *Jour. of Nerv. and Mental Disease*, July, 1889.

## PRACTICUM XI: DISSECTION OF THE SHEEP'S BRAIN CONTINUED;

### STUDY OF TRANSECTIONS.

§ 1. *Exposing the Right Paracœle.*—This may be done (see Pr. X, § 8) with some confidence at the cephalic and caudal ends, using the left as a guide, since presumably the parts are at the same level on the two sides.

§ 2. *Removing the Callosum.*—Between the two paracœles and slightly overhanging their mesal parts is the mesal portion of the callosum. The overhanging thin portions are to be trimmed off carefully with scissors,

§ 3. *The Septum.*—But when the intermediate portion of the callosum is removed it will be found that the two paracœles are separated at the meson by a thin partition which is *very easily torn*. This is the SEPTUM (*septum lucidum* of Human Anatomy).

§ 4. *The Pseudocœle.*—By reference to Plates XXII, XXIII and XXIV and to Pract. IX, § 19 it will be seen that this partition between the two paracœles is really double; each half, HEMISEPTUM, represents part of the mesal wall of the corresponding paracœle. Their dorsal portions are often so thin and so closely apposed as to be separated with difficulty; in Pl. XXIV they and the intervening slit-like pseudocœle are too thick.

§ 5. *The Genu and Splenium.*—At the cephalic end the callosum turns ventrad, as seen in Pl. XXIII; it also extends laterad and cephalad, the right and left halves diverging at about a right angle. The conditions are nearly the same at the caudal end, the splenium.

§ 6. On the left side, from the region between the cephalic slope and the medicornu (corresponding nearly on Pl. XXIV with the unshaded area between lines 5 and 9) remove a slice 2–3 mm. thick. Note:

a. The undulations of the cortex, corresponding with the INSULA (island of Riel) of the human brain, less covered in the sheep.

b. The gray mass of caudatum, constituting thus an ENTOCINEREA.

c. The intermediate alba into which more or less of the entocinerea intrudes in streaks, giving the appearance which has caused the name STRIATUM to be applied to this thickened portion of the parietes.

d. If time permits make a drawing of this section.

§ 7. *Demonstration of the Porta.*—Remove part of the caudatum as follows: On Pl. XXIV draw two pencil lines from a point corresponding with the bottom of the fissure 8 respectively to the mesal end of lines 5 and 9. Cut along the two lines holding the scalpel so that it is at about 45° with the cut dorsal surface. On pushing out the piece thus separated and trimming off the free cephalic end of the paraplexus there will be found an orifice 2–3 mm. long and about 1 mm. wide, oblique in direction and admitting the tracer or probe meso-ventro-caudad. This is the PORTA (foramen of Monro) of the left side, the sole communication between the left paracœle and the aula, the mesal division of the proscœle, and thus indirectly the other mesal cavities; see *Handbook* Figs. 4710, 4729, 4739–4745, and Pract. IX, § 14 a.

§8. *Demonstrating the Continuity of the Paracœle with the Rhinocœle.*—This continuity is shown from the dorsal side in Fig. 3 and from the ventral in preparation No. 2653. It may be exposed from the left side as follows :

a. From the left side cut off successive slices, being guided by the dotted line 4 in Pl. XXIV and by the line of the paracœle. The resultant surface will be concave, and look laterad and also slightly dorsad. If the cuts are made cautiously the precornu may be traced through the olfactory crus as a very narrow passage, expanding considerably in the bulb. Compare *Handbook* Fig. 4729 and *Anatomical Technology*, Pl. IV, Fig. 16. This stage should be drawn from the left side if time permits.

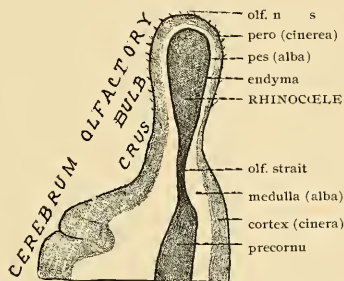


FIG. 3. LEFT OLFACTORY BULB OF THE SHEEP, THE RHINOCŒLE EXPOSED ;  $\times 2$ . From a preparation by Dr. P. A. Fish.

The object is to show the continuity of the paracœle with the cavity of the olfactory bulb through the narrow strait. Compare Plates XVIII and XXII. See Pract. IX, § 6, for fuller consideration of the relations of these cavities.

§9. *The Precommissure.*—On Pl. XXIII note the location of the mesal section of the commissure just ventrad of the porta. Draw an imaginary line on that figure, or on a real meson, beginning at the depression (posteribrum) just caudad of the albicans, passing between the chiasma and the precommissure, then ventrad to the genu and so to the cephalic convexity of the cerebrum.

a. From the specimen cut away so much as may be estimated to lie ventrad of this line, being guided by the location of the porta, the level of which should not be reached by the first incision by at least 2 mm.

b. On the right may be recognized the alternate streaks of alba and cinerea constituting the striatum which has been divided on the left by a sagittal section (§ 6, c).

c. From the region just ventrad of the porta very cautiously remove thin slices, until, just cephalad of the mesal cavity (cephalic part of diacœle), there appears a well defined tract of alba about 1 mm. in diameter, crossing the meson and curving cephalad so as to form a crescent. This is the PRECOMMISSURE (anterior commissure). The cephalic arms might be traced to the olfactory bulbs, of which they constitute a commissure, as seen in preparation No. 2653; a pair of caudal arms is less easily traced into the corresponding hemicerebrums.

§10. *The Aula and Portas.*—Dip both the specimen and the scalpel in alcohol; note the location of the porta as exposed on the left side; apply the edge along the oblique sinistro-cephalic margin of the cerebrum



as left by the previous dissection, and at one sweep remove so much as lies ventrad of the middle of the porta.

a. If both portas have been thus transected they will be found to be narrow passages converging caudo-mesad to a small mesal cavity, the AULA.

§ 11. The cut area cephalad of the transverse passage thus constituted is nearly square, its four sides forming angles of about  $45^\circ$  with the meson, but the two cephalic sides are prolonged as the nearly parallel borders of a thin mesal extension, the SEPTUM between the two paracœles; commonly called *septum lucidum*.

a. If the tracer (better the syringotome) be applied accurately at the middle of the total area and gently pushed cephalad upon the meson, the tip of the left index being at the time applied just dorsad of the cut end of the mass, it will be found that the apparently continuous surface may, in its cephalic portion, be separated at the meson into a right and left portion, each tapering into the corresponding half of the thin projection just mentioned.

b. Each of these thin lateral parts is a HEMISEPTUM; the mesal space between them is the PSEUDOCÆLE ("fifth ventricle") Pl. XXIII, Pract. IX, § 19, b, and Plates XXIV and XXV.

The thicker lateral portions are the FORNICOLUMNS (pillars of the fornix) united at the meson; see § 31.

c. The masses just caudad of the portas are the THALAMI, joined across the meson by the large MEDICOMMISSURE, which, unlike the pre-commissure, consists of cinerea. The cut surfaces exposed present, besides some smaller tracts, extensive areas of alba diverging from the pons cephalad in the crura, and laterad of the thalami as the "internal capsule" and radiating in the substance of the cerebrum.

§ 12. Remove the remnant of the right striatum along the cephalic margin of the fimbria, and transect the left hippocamp, *etc.*, at the same level as the right; the brain is now nearly symmetric.

§ 13. Trim off so much of the caudal end of each hemicerebrum as lies caudad of the medicornu, that is, so much as in Pl. XXIV projects beyond the furrow marked 10; this will include also the splenium, the caudal end of the callosum. While cutting, a finger should be kept upon the middle of the mass to steady it.

a. There will now be exposed the large PREGEMINUM, already seen in Pl. XXII, and at the meson, upon its cephalic margin, a soft, ragged mass. This might well be mistaken for the conarium, but it is really the membranous sack upon the conarium itself, indicated inadequately in Pl. XXIII, and mentioned in Pract. IX, § 12, e. The tip of the sack has perhaps been opened in cutting off the splenium; it should be cut off cleanly with the scissors to expose its considerable cavity and the plexuses that cover its ental surface. The examination of the conarium itself may be deferred for the present.

§ 14. *The Fornix.*—The curved, cap-like mass now visible cephalad of the pregeminum and conarium is composed of the following parts: The two fimbrias at the margins; the two hippocamps nearer the meson; at the meson, the remnant of the septum; and, concealed thereby, the conjunction of the two pairs of parts. Now although the hippocamp and

fimbria of either side are primarily mere constituents of the floor of the paracœle of that side, yet since the fimbria is, in one sense, disconnected from the parietes at the opposite side of the rima, and since the hippocamps are united at the meson, therefore it is often convenient to deal with this secondary combination of parts under the single name, FORNIX ; see *Handbook*, VIII, pp. 138-139.

§ 15. *Removal of the Fornix.*—In the preparation from which Pl. XXII was drawn, the fornix was pushed off hastily, carrying with it the membranous roof of the diacœle. This may be avoided as follows :

*a.* At either side lift the cut end of the fimbria and hippocamp enough to disclose vessels and bands passing between them and the subjacent parts ; divide these with the scissors and repeat on the other side till the meson is approached ; here special pains must be taken, and it may be necessary with the forceps to pull the conarial sack from the recess between the mesal ends of the gyres bordering the hippocamp fissure.

*b.* When the lateral and caudal parts of the fornix are free the whole may be gently pushed dorsad and disconnected ; dip it in alcohol.

§ 16. *The Conarial Sack.*—Push this away from the conarium a little and place the tip of the thumb on the apex of the conarium so as to steady it ; the sack may then be pushed and pulled from the dorsal (properly cephalic) aspect of the conarium.

§ 17. *The Velum.*—The pia covering the diencephal and mesencephal and the apposed ventral surface of the fornix constitutes the VELUM. Its latero-cephalic borders are the paraplexuses ; one of these has been trimmed off but the dorsal part of the right should remain ; Pract. X, § 21.

§ 18. *The Velar Vein.*—This was mentioned in Pract. IX, § 25, *a.* It may now be seen just cephalad of the conarium, formed by the junction of a pair from opposite sides. The corresponding velar arteries are not easy to recognize unless the arteries have been injected.

§ 19. *The Diatela.*—At the meson and for 2-3 mm. at either side the velum covers the diacœle ; it is here more vascular, and thicker from the fusion with it of the endyma, and from the formation of the diaplexuses ; this mesal strip is the DIATELA, seen in transection in Pl. XXV.

§ 20. The cephalic end of the diatela presents a deep notch, corresponding to a triangular area (the DELTA) on the ventral surface of the fornix which here constitutes the roof of the aula ; see *Anatomical Technology*, § 1217, and Pl. IV, Fig. 14.

§ 21. *The Habena.*—Introduce at the notch just indicated the point of the narrower blade of the scissors and medisection the diatela to the hole made by cutting off the sack (§ 30). Reflect the halves in opposite direction. At the sides of the diacœle will be seen the HABENAS already studied from the mesal aspect in Pract. IX, § 16. If the dissection has been done carefully, just laterad of the habena will be recognized the line of reflection of the endyma upon the diatela constituting the lateral boundary of the diacœle. If upon either side the diatela and velum be torn off, along that line will be left a membranous ridge, the RIPA, the ragged edge of the combined pia and endym. This ripa may be traced

to the dorsal end of the porta, and thence latero-caudad along the rima.

§ 22. *The Medicommissure.*—This has been cut from the ventral aspect in § 11, *c*, and is shown in Plates XXIII and XXV. Its presence, size and circular outline may be recognized now by divaricating the thalami slightly and letting the light strike between them. In the sheep as in most mammals it is much larger than in man.

§ 23. *The Study of Transections.*—To each four members of the section will be supplied a set of transections of one brain, to be handled with great care. But if preferred, as suggested in Pract. X, § 2, *a*, certain of their own specimens may be transected, and then examined more freely.

§ 24. The following general propositions, suggestions, and directions as to the study of transections of the brain apply for the most part to other organs, to entire animals and in some respects to microscopic sections as well.

§ 25. The two cut surfaces resulting from a transection at a given level are identical in form and composition.

*a.* After the section is made one or both of the surfaces may be trimmed or sliced off, or imprinted or otherwise modified from its original condition, but this does not affect the correctness of the general proposition.

§ 26. When a transected region contains a cavity both cut surfaces will present interruptions of equal area and form.

§ 27. If the transected cavity continues of uniform shape, size and direction in both directions then photographs or shaded drawings of the two surfaces will be identical in that respect also.

*a.* But if the cavity changes in size, shape or direction, then corresponding differences will appear in the photograph or in an accurate shaded drawing.

§ 28. Absolute transections of a perfectly symmetric mass, *e. g.*, a regular, homogeneous cylinder, will produce symmetric cut surfaces; *i. e.*, the right and left will be identical in form and composition although reversed in direction.

*a.* But, firstly, even were the two halves of a brain absolutely identical, originally, some asymmetry always results from the manipulations and agencies to which it is subjected.

*b.* Secondly, it is probable that no absolutely exact transection of a large and complex brain like that of the sheep is ever made.

§ 29. The student must be prepared for recognizable and sometimes marked differences between the right and left sides of the section.

*a.* An absolutely symmetric drawing of a transection justifies the inference that one side has been simply copied from the other.

§ 30. In drawing transections of the brain, and indeed of most organs or organisms, there commonly arises a practical difficulty due to the great difference in the size of parts. A drawing of moderate size may leave the smaller features obscure, while an enlargement of the whole such as to exhibit these features clearly may waste space and time.

§ 31. The difficulty may be met in either of three ways :

1. The whole may be shown of moderate size and the more complex areas enlarged sufficiently as separate drawings. This is the common method with maps and is employed on Pl. XXV.

2. The whole may be enlarged, but time may be saved by not including certain features where the omission would occasion no misapprehension. For example, on Pl. XXIII the subdivisions of the cerebellum are omitted, the omission being stated in the description. On Pl. XXV a part or all of the cinerea might have been indicated merely by a line corresponding with its ental margin.

3. With transections, unless it be desired to exhibit differences between the two sides, natural or caused by the obliquity of the section, a portion of one side may be omitted altogether, as in Fig. 122 of Anatomical Technology.

Whichever method is adopted it is well to remember that drawings are seldom on too large a scale.

§ 32. While it is desirable to maintain the natural proportions of the several parts and cavities, the cavities may be somewhat reduced, if necessary, in order to afford space for the distinct representation of outlines.

*a.* For instance, the cavities of the diacœle and the paracœle may be encroached upon for the sake of indicating distinctly the membranes and plexuses.

*b.* On the other hand, where the parts are superposed, as the cerebellum upon the geminum and the cerebrum on the cerebellum, it is permissible to increase the distance between them so as to represent the outlines, meninges, etc.

§ 33. Keeping in mind what was said in § 26, an admirable test of the student's powers of observation, interpretation and delineation will be afforded by his drawing the two cut surfaces made by a given transection at two different times and then comparing; still more severe will be the test if these surfaces, or one of them, be so drawn by two individuals.

§ 34. The general level of a transection may be determined by uniting the section with its neighbors.

§ 35. The exact level may require the detailed comparison of the principal or most easily identified features (cavities or masses) with the meson (Pl. XXIII) and with the dissections (Plates XX-XXIV).

§ 36. It will be easier for the beginner to take first the mesencephalic transection (D) both because a single segment only is included and because the cavities and walls are comparatively simple. Next sections G and F, then C and B, and lastly E (Pl. XXV).

§ 37. Section C presents special difficulties of two kinds.

*a.* The cerebellar outline is very irregular on account of the numerous folia and the intervening rimulae. These need be represented on one side only.

*b.*—The cavity is a horse-shoe-shaped slit, concave dorsad, and nearly filled by a projecting mesal lobe of the cerebellum. But really between this lobe and the oblongata there is a delicate lamina, the lingula (Pl. XXIII). The space ventrad of the lingula is the epicele, a part of the true brain cavity; the space dorsad is seen in Pl. XXIII.

§ 38. With section B the conditions are similar. Between the post-

oblongata and the overhanging cerebellum intervenes the membranous metatela, the roof of the metacœle, and this may adhere so closely to the cerebellum as to be at first ignored.

§ 39. With section F the main difficulty is due to the thinness of the dorsal part of the septum and the narrowness of the pseudocœle between the two halves.

§ 40. *Defibrillation*.—The fibrous structure of certain regions may be roughly demonstrated upon a half-brain as follows:

*a.* Grasp the *chiasma* and pull latero-dorso-caudad. The OPTIC TRACT may be separated from the subjacent parts and traced, gradually widening, over the lateral aspect of the pregeniculum and perhaps to the pregeminum.

*b.* Grasp the *cerebellum* and pull laterad and then ventrad; the MEDIPEDUNCLE will be seen to be continuous with the pons.

*c.* Grasp the *olfactory bulb* and pull ventro-caudad so as to tear off the OLFACTORY TRACT.

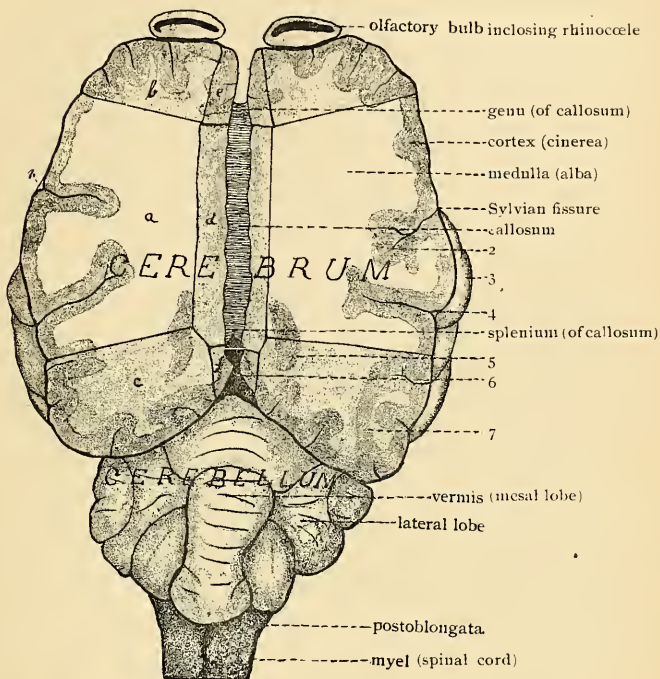
*d.* Divide the *postoblongata* by a sagittal section. Pull the lateral and mesal portions apart slowly and steadily. The separation will continue into the cerebrum and the fibrous structure will be particularly obvious in the CRUS.







THE BRAIN OF THE SHEEP, THE CEREBRUM SLICED TO NEAR THE LEVEL  
OF THE CALLOSUM;  $\times 1.5$ .



The following points are illustrated :

A. The general proportions of the two great masses, CEREBRUM and CEREBELLUM.

B. The constitution of the cerebellum by a mesal lobe (VERMIS) and a pair of LATERAL LOBES.

C. The junction of the two halves of the cerebrum by a thick sheet of fibers, the CALLOSUM; its rounded cephalic and caudal margins are the GENU and SPLENIUM, respectively; Pl. XXIII.

D. The relative positions of the two kinds of substances in the larger part of the cerebrum; the ALBA (white substance) is central; the CINEREA (gray substance) is peripheral, constituting the CORTEX.

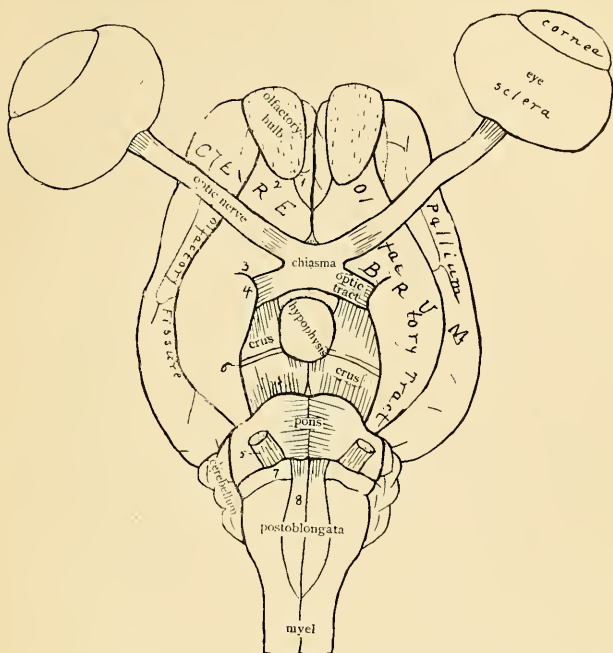
E. The relation of the cortex to the FISSURES.

F. The passage of the ARACHNOID membrane across the mouths of the fissures, as at 1 and 4, while the PIA dips to the bottom as a fold.

G. The existence of a cavity (RHINOCŒLE or olfactory ventricle) in the OLFACTORY BULB; see Pl. XXIV and p. 69, Fig. 3.

*Defects.*—The cerebellar divisions (FOLIUMS) are not shown in detail. In the dark interval (6) between the cerebellum and cerebrum should appear the cut ends of vessels one of which is shown in Pl. XXIV. There is no indication of the thin layer of cinerea on the dorsum of the callosum; Pl. XXV.





VENTRAL ASPECT OF THE SHEEP'S BRAIN WITH THE EYES ATTACHED;  $\times 1.3$ .

From the specimens commonly examined the brain here represented differs as follows :  
*a.* The EYES have been retained with OPTIC NERVES. *b.* The HYPOPHYSIS is retained. *c.* Besides the TRIGEMINUS NERVES (marked 5), on the actual brains there are more or less distinct signs of the roots of the other cranial nerves.

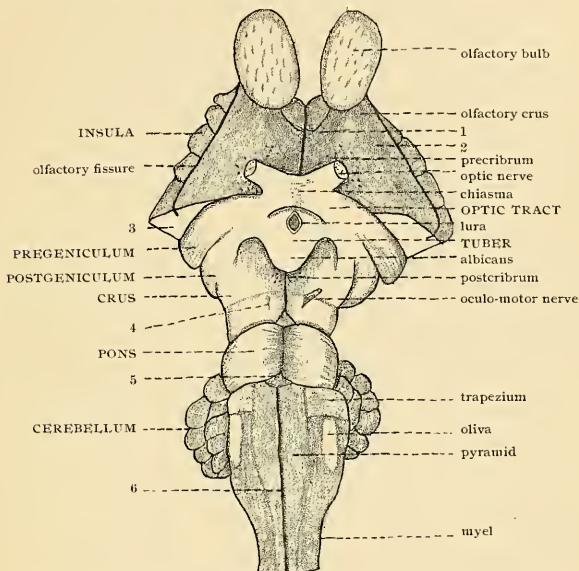
The numbers indicate parts as follows : 1, a small portion of the PALLIUM or fissured region of the CEREBRUM, projecting mesad of the OLFACTORY BULB. 2, the OLFACTORY CRUS, connecting the OLFACTORY TRACT with the BULB. 3, a slightly depressed area just cephalad of the OPTIC TRACT. 4, a part which distinctly projects over the tract. 5, The root of the TRIGEMINUS, the great sensory nerve of the face. 6, a slight ridge, not always distinct, crossing the CRUS. 7, the TRAPEZIUM, concealed in the human brain, by the caudal margin of the broad PONS. 8, the PYRAMID, less distinct than in man and not exhibiting a DECUSSATION.

Some details are more fully shown in Pl. XX.



# PHYSIOLOGY : PRACTICUM VIII: PLATE XX.

BASE OF SHEEP'S BRAIN AFTER THE REMOVAL OF THE HYPOPHYSIS AND PARTS OF THE CEREBRUM AND CEREBELLUM ; enlarged.



The cephalic and caudal regions are nearly the same as in Pl. XIX, but the following differences should be noted : *a.* The absence of the frontal parts of the cerebrum between and laterad of the OLFACTORY BULBS. *b.* The indication of the MESAL (1) and LATERAL (2) ROOTS of the bulb. *c.* Between the two the irregular triangular area, PRECRIBRUM ("anterior perforated space") presenting orifices for the transmission of vessels. *d.* The removal of the HYPOPHYSIS ; this exposes a slight elevation, TUBER, and an orifice, lura, leading into the diacœle. *e.* The CRURA and OPTIC TRACTS are more fully seen. *f.* The PONS presents more distinctly the mesal emargination of its caudal margin.

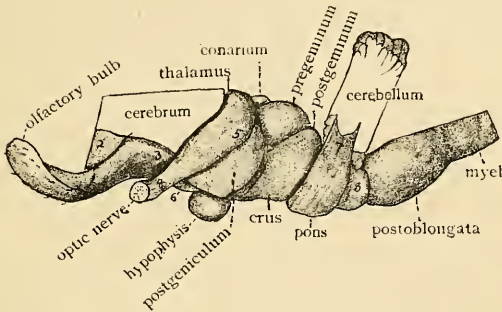
1, Mesal root of olfactory bulb. 2, lateral root. 3, cut surface of olfactory tract and pallium. 4, depression caused by the extraction of the right oculo-motor nerve. 5, Caudal emargination of the pons. 6, Ventral mesal sulcus of the oblongata. The unnamed shaded line across the crus just cephalad of the oculo-motor nerve was intended to represent the cimbria.





# PHYSIOLOGY: PRACTICUM VIII: PLATE XXI.

LEFT SIDE OF THE SHEEP'S BRAIN AFTER THE REMOVAL OF MOST OF THE CEREBRUM AND CEREBELLUM ;  $\times 1$ .



The CEREBELLUM is left of its natural height, but the cephalic and caudal convexities are sliced away so as to expose the parts which are overhanging by them. In a companion preparation the dorsal portion of the cerebellum has also been removed, with the cephalic and caudal convexities, but the lateral "overhangs" are retained.

The CEREBRUM has been cut down to the level of the THALAMI; the caudal portion cut away along the oblique line of its projection over the part marked 5; the lateral portion so as to expose the part marked 3; also the cephalic projection which, as seen in Plates XIX and XXV, overhangs the OLFATORY BULBS.

The short lines on the surface of the olfactory bulb represent the OLFATORY NERVES. The cut end of the left OPTIC NERVE is dotted to indicate its fibrous structure.

1, OLFATORY CRUS; compare with Pl. XX. 2, a part of the PALLIUM which has not been cut. 3, OLFATORY TRACT. 4, (indistinct), CHIASSA. 5, PREGENICULUM (external or anterior geniculate body), distinct in man but here little more than a lateral portion of the thalamus. 6, TUBER (*cinereum*), the slight convexity to which the HYPOPHYSIS is attached; in Pl. XX it is the area just caudad of the chiasma. 7, the MEDIPEDUNCLE, continuing the PONS to the lateral mass of the cerebellum. 8, the TRAPEZIUM; compare with Pl. XX.

Excepting the unshaded areas, representing cut surfaces, all the parts seen in this figure were covered by PIA.

At the dorsal end of the cerebellum are seen a few FOLIA, its leaflet-like divisions; these are not shown in any other plate.

Besides facilitating the recognition of certain important parts this figure well illustrates the *segmental constitution* of the brain, which is obscured in the entire organ by the preponderance of the cerebrum and cerebellum. There is a series of more or less distinct masses demarcated by constrictions of greater or less depth. Admitting that there is still some doubt as to number and limits of the segments the following assignments may be accepted provisionally:

Olfactory bulbs and crura, } RHINENCEPHAL.

Cerebrum } PROSENCEPHAL (fore brain).

Thalami, conarium, hypophysis, } DIENCEPHAL (inter-brain).  
chiasma, and geniculums, }

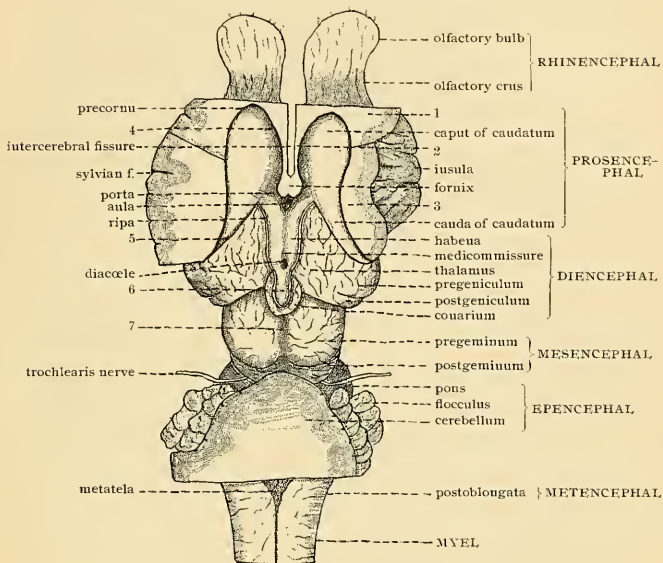
Geminums and crura } MESENCEPHAL (mid-brain).

Cerebellum, pons and preoblongata, } EPENCEPHAL (hind-brain).

Postoblongata } METENCEPHAL (after-brain).



DORSUM OF SHEEP'S BRAIN AFTER THE REMOVAL OF PARTS OF THE CEREBRUM AND CEREBELLUM.



Compare with Pl. XVIII. From the cerebellum have been cut the dorsal part and also the caudal. On the cut dorsal surface are seen the central alba and the peripheral cinerea, but the outline of the latter is diagrammatic only. At the sides are the tiers of foliums constituting the flocculus.

From the cephalic end of the cerebrum have been cut the parts projecting over the olfactory crura, but part of the cephalic slope marked *b* in Pl. XVIII is here marked 1. With the dorsal portion were removed the entire callosum and the fornix excepting the cephalic vertical part. This and the mesal walls of the paraccele are really cut at a lower level than the larger cut surface on the left. On the right the insula has been exposed by pushing up and breaking off the overhanging parts. The ectal surfaces, covered by pia, are indicated by irregular lines representing the blood-vessels.

The ental surfaces, covered by endyma, are those of the caudatums in the paraccelles, the habenas, medicommisura and conarial pouch; and the floor of the aula and portas.

The irregular line laterad of the habena and extending around the endymal area on the conarium represents a ripa (shore-line). It consists of the cut or torn edges of the pia from the dorsum of the thalamus and of the endyma from the habena which united to form a membranous roof of the diaccele, the DIATELA, which has been removed.

Similarly the pial, dorsal surface of the thalamus is demarcated from the endymal surface of the caudatum by a ripa which meets the other at the porta.

The CONARIUM, although a constituent of the DIENCEPHAL, is tilted caudad so as to rest upon the PREGEMINUM, and the mesal part of its exposed surface is likewise covered by endyma.

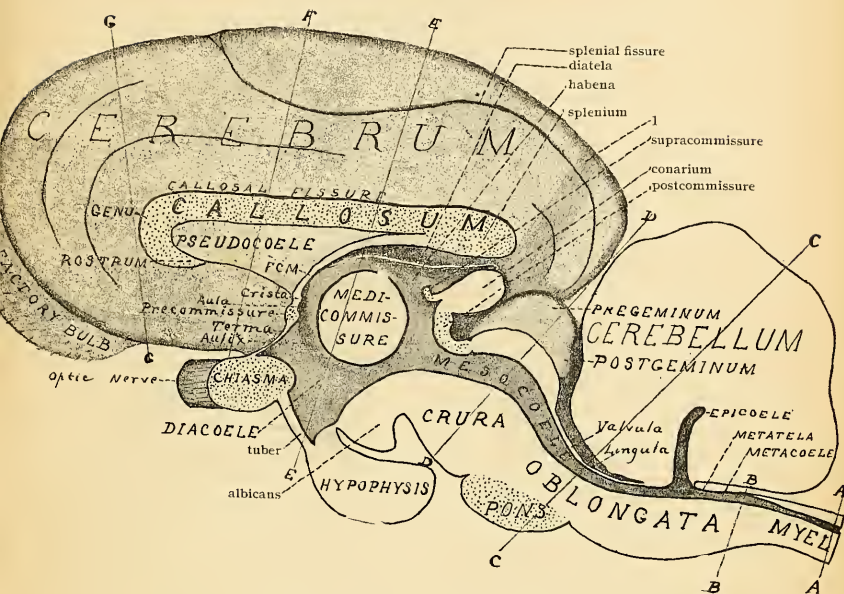
1, cephalic slope. 2, mesal wall of PARACCELE; at a higher level this would be one of the HEMISEPTUMS. 3, horizontal cut surface of cerebrum. 4, the mesal, vertical portion of the paraccele. 5, indicates the location of the ripa between the thalamus and caudatum, but it is overhung by the latter so as not to appear in this view. 6, extension of the diaccele upon the conarium. 7, mesal furrow of the pregeminum.





PHYSIOLOGY: PRACTICUM IX: PLATE XXIII.

MESAL ASPECT OF RIGHT HALF OF SHEEP'S BRAIN;  $\times 2$ .



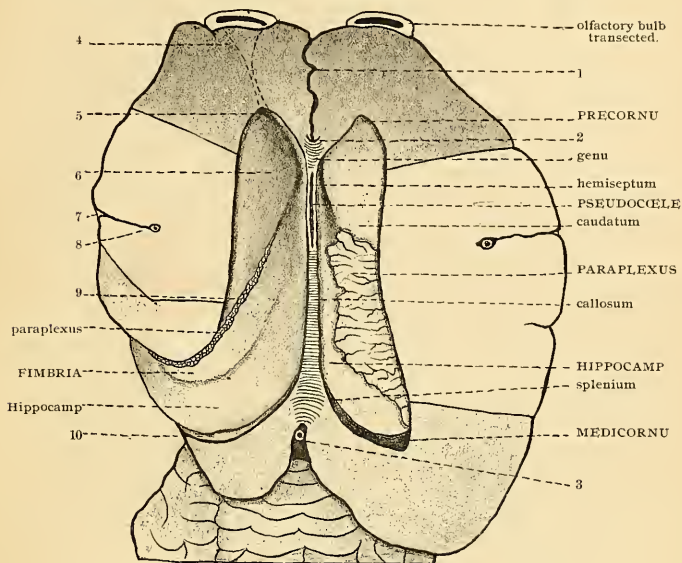
This figure is semi-schematic, certain details being omitted for the sake of clearness, *e. g.*, the divisions of the CEREBELLUM, the VESSELS, and the MEMBRANES, ARACHNOID and PIA. The pia, however, is represented by the line between the ROSTRUM and the CRISTA.

The tuber is the *Tuber cinereum*, called *torus* in the former edition.

The objects of the figure are: To show most of the MESAL PARTS; to illustrate ENDYMAL CONTINUITY and its concomitant, CÆLIAN CIRCUMSCRIPTION; to indicate the PLANES OF TRANSECTION which are most instructive, A—G. Compare Plates XX, XXII, XXIV XXV. For fuller description see Practicum IX.



SHEEP'S BRAIN, THE PARACÆLES (lateral ventricles) EXPOSED;  $\times 2$ .



This figure represents a stage of dissection intermediate between Plates XVIII and XXII. By the removal of successive slices the PARACÆLES have been opened; the left has then been more completely exposed by oblique sections, and the PARAPLEXUS trimmed off so as to expose the wide FIMBRIA and the furrow between it and the HIPPOCAMP. The plane of section did not coincide exactly with the CALLOSÚM; the caudal three-fifths of this is represented by the transverse lines; also the cephalic end, the GENU; but an intermediate portion is wholly removed, exposing the narrow PSEUDOCÆLE ("fifth ventricle") and its thin lateral walls, HEMISEPTUMS. The HEMISEPTUM is here shown to be only a portion of the general mesal wall of the paracæle. The Pseudocæle (Pl. 25) has no connection with the true cavities of the brain. The only communications of the paracæles are through the PORTAS with the mesal AULA (Pl. XXII).

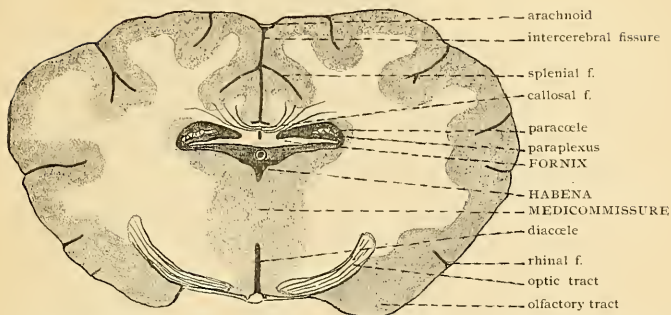
The two FIMBRIAS and HIPPOCAMPS connected by a mesal part (Pl. XXV) constitute the FORNIX.

The HIPPOCAMP is sometimes called *hippocampus major*.

1, INTERCEREBRAL FISSURE. 2, CALLOSAL FISSURE. 3, VESSEL. 4, interrupted lines indicating the continuation of the paracæle into the RHINOCÆLE. 5, PRECORNU. 6, CAPUT of the CAUDATUM. 7, SYLVIAN FISSURE crossed by ARACHNOID. 8, VESSEL at bottom of fissure. 9, CAUDA of CAUDATUM. 10, part of caudal wall of paracæle.

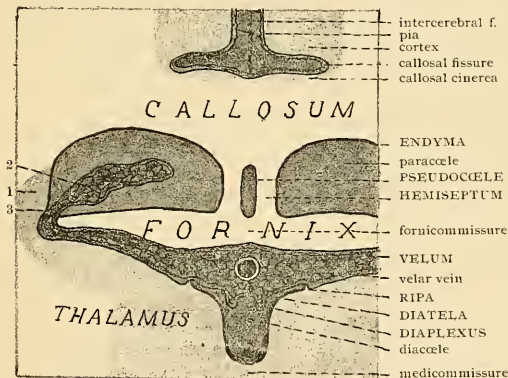


A. TRANSECTION OF SHEEP'S BRAIN ;  $\times 1.5$ .



The plane of section approximates *E* in Pl. XXIII. The HYPHYSIS has been removed and the DIACŒLE is open ventrad at the LURA (Pl. XX). The OPTIC TRACT is cut obliquely ; its fibrous structure is roughly indicated by lines. The masses connected by the MEDICOMMISSURE are the THALAMI. The CALLOSUM is indicated by lines. The INTERCEREBRAL FISSURE is bridged by the ARACHNOID ; in man the falx descends into the fissure for a greater or less distance carrying the arachnoid before it. The fissure here named *rhinal* is named *olfactory* in Pl. XIX.

B. ENLARGEMENT OF THE CENTRAL REGION OF A.



This was designed to exhibit more clearly the relations of the CAVITIES to the MEMBRANES and PLEXUSES, but some points are obscured by the shading.

The mesal DIACŒLE and the lateral PARACŒLES are lined by smooth ENDYMA, represented by a heavy line. In the diacœle the endyma may be traced dorsad upon the mesal surface of the THALAMUS and over the dorso-mesal ridge representing the HABENA, as far as the point called RIPA, (see Pl. XXII, left side.) Here it is reflected mesad upon the ventral surface of the VELUM.

The velum consists of the PIA covering the ventral surface of the FORNIX and the dorsal surface of the thalami, together with CONNECTIVE TISSUE and VESSELS (of which only one is shown). Near the meson there hangs into the diacœle at each side a plexus (DIAPLEXUS) covered by the endyma.

At the interval (RIMA) between the margin of the fornix and the caudatum (1) the velum extends into the paracœle as the PARAPLEXUS, covered, however, by the endyma which is reflected off at 3 and the point opposite.

A thin layer of the cortex extends across the callosum.

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